131

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-015860
(43)Date of publication of application : 19.01.2001

(51)Int.Cl. H01S 5/22

(21)Application number : 11-328397
(22)Date of filing : 18.11.1999

(71)Applicant : FUJITSU LTD
(72)Inventor : KUBOTA SHINICHI
HORINO KAZUHIKO
KURAMATA AKITO

(30)Priority

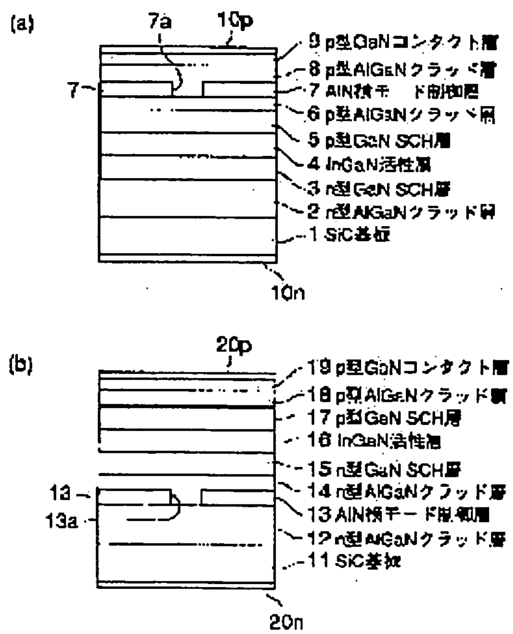
Priority number : 11118742 Priority date : 26.04.1999 Priority country : JP

(54) SEMICONDUCTOR LIGHT-EMITTING DEVICE AND ITS MANUFACTURE

(57)Abstract:

PROBLEM TO BE SOLVED: To easily control a III-V compound semiconductor laser in a lateral mode, improve the aspect ration of a laser beam, and reduce damages by the growth and patterning of an AlN layer.

SOLUTION: A lateral mode control layer 13 or 7 of AlN with a thickness of 0-300 nm is provided either of between N-type clad layers 12 and 14 or between P-type clad layers 6 and 8, or between one of the above clad layers and an active layer. A mask layer is formed on a substrate, an AlN layer is formed to cover the mask layer, and the AlN layer is lifted off by the



use of a solution that is capable of etching the mask layer.

LEGAL STATUS

[Date of request for examination]	13.11.2003
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]
[Claim 1] Semiconductor luminescence equipment characterized by providing the following. It is inserted into a 1 conductivity-type cladding layer and an opposite conductivity-type cladding layer, and is III. A barrier layer which consists of a group nitride AlN which is formed between one [at least] cladding layer of said 1 conductivity-type cladding layer or said opposite conductivity-type cladding layer, and a barrier layer in one [at least] cladding layer of said 1 conductivity-type cladding layer or said opposite conductivity-type cladding layer, has opening for current and has thickness of 300nm or less more greatly than 0 from -- a becoming transverse-mode control layer
[Claim 2] It is AlN to the production process which forms a stripe-like mask layer on a substrate, and the substrate surface containing said mask layer. Said AlN formed in a side wall and the upper surface of said mask layer while etching said mask layer using a production process which forms a layer, and a solution which can etch said mask layer The manufacture method of the semiconductor luminescence equipment characterized by to have a production process which carries out lift off of the layer.
[Claim 3] Said AlN A layer is the manufacture method of a semiconductor light emitting device according to claim 2 characterized by being formed at substrate temperature of 500 degrees C or less by spatter.
[Claim 4] AlN which was formed in a current constriction field in an up cladding layer and a lower cladding layer which bandgap energy consists of a large gallium nitride system compound semiconductor from a barrier layer which consists of a gallium nitride system compound semiconductor, and said barrier layer, and sandwich said barrier layer, and said up cladding layer, and has started on both sides of a current passage field Or AlGaN Or GaN from -- semiconductor luminescence equipment characterized by having a becoming insulating layer.
[Claim 5] Semiconductor luminescence equipment characterized by providing the following. A barrier layer which consists of a gallium nitride system compound semiconductor An up cladding layer and a lower cladding layer which bandgap energy consists of a large gallium nitride system compound semiconductor from said barrier layer, and sandwich said barrier layer AlN which is formed in a current constriction field in said up cladding layer, and has a opening to a current passage field Or AlGaN Or GaN from -- a becoming insulating layer for current constrictions A high resistance field where an impurity of said up cladding layer of said insulating-layer bottom was inactivated
[Claim 6] Semiconductor luminescence equipment according to claim 5

characterized by introducing hydrogen, nitrogen, and an argon into said high resistance field.

[Claim 7] Said insulating layer is semiconductor luminescence equipment according to claim 5 characterized by having started on both sides of said current passage field.

[Claim 8] A manufacture method of semiconductor luminescence equipment characterized by providing the following. A production process which forms a 1 conductivity-type cladding layer on a substrate A production process which forms a barrier layer on said 1st conductivity-type cladding layer A production process which forms the 1st opposite conductivity-type cladding layer on said barrier layer A production process which forms a stripe-like mask on said 1st opposite conductivity-type cladding layer, A production process which carries out dry etching of the field which is not covered with said mask, and forms the mesa section in said 1st opposite conductivity-type cladding layer at least, It is AlN on said mask and said 1st reverse conductivity-type cladding layer. Or AlGaN Or GaN A production process which forms a becoming insulating layer, A production process which also removes said insulating layer on said mask by removing said mask, and a production process which forms the 2nd opposite conductivity-type cladding layer and contact layer on said insulating layer and said 1st opposite conductivity-type cladding layer

[Claim 9] A manufacture method of semiconductor luminescence equipment characterized by providing the following. A production process which forms a 1 conductivity-type cladding layer on a substrate A production process which forms a barrier layer on said 1st conductivity-type cladding layer A production process which forms the 1st opposite conductivity-type cladding layer on said barrier layer A production process which forms a stripe-like mask on said 1st opposite conductivity-type cladding layer, It is AlN on said mask and said 1st opposite conductivity-type cladding layer. Or AlGaN Or a production process which forms an insulating layer which consists of GaN, A production process which introduces hydrogen, nitrogen, or an argon into said 1st opposite conductivity-type cladding layer of a field which is not covered with said mask from the outside, and forms a high resistive layer, A production process which also removes said insulating layer on said mask by removing said mask, and a production process which forms the 2nd opposite conductivity-type cladding layer and contact layer on said insulating layer and said 1st opposite conductivity-type cladding layer

[Claim 10] A manufacture method of semiconductor luminescence equipment according to claim 9 characterized by having further a production process which carries out dry etching of the field which is not covered with said mask, and forms the mesa section in said 1st opposite conductivity-type cladding layer at least.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the semiconductor luminescence equipment used for the object for reading of optical-magnetic disc equipment, the light source for writing, or the light source for laser beam printers, and its manufacture method in more detail about semiconductor luminescence equipment and its manufacture method.
[0002]
[Description of the Prior Art] III Many things of the ridge mold which can be formed simple, without group nitride semiconductor laser including the production process of re-growth of the crystal of the dry etching production process of a barrier layer, a current constriction layer, etc. are used. III of such a ridge mold GaN as shown in JP,4-242985,A as group nitride semiconductor laser There are some which have a compound semiconductor layer.
[0003] As the ridge type of semiconductor laser, it is drawing 1 (a). Drawing 1 (b) There are some which have structure as shown. first, drawing 1 (a) the shown semiconductor laser -- setting -- a silicon-on-sapphire 111 top -- alumimium nitride (AlN) the 1st cladding layer 113 which consists of the becoming buffer 112 and n mold aluminum gallium nitrogen (AlGaN) -- MOVPE (metalorganic vaporphase epitaxy) -- it is formed of law. then, the 1st cladding layer 113 top of the field which is not covered by SiO2 film after covering a part of surface of a cladding layer 113 by the diacid-ized silicon (SiO2) film (un-illustrating) -- GaP The becoming barrier layer 114 and the p mold AlGaN the 2nd becoming cladding layer 115 -- MOVPE -- it forms in order by law.
[0004] And after fluoric acid removes SiO2 film, SiO2 another film 116 is formed on the 2nd cladding layer 115. Aperture 116a for electrode connection is formed in the SiO2 film 116 by the photolithography method. Subsequently, the p lateral electrode 117 and the n lateral electrode 118 are formed, respectively on the 2nd cladding layer 115 exposed from aperture 116a, and the 1st cladding layer 113 of the side.
[0005] By the above, it is GaN of a ridge mold. The basic structure of a system semiconductor laser diode is completed. By the way, as a substrate used for the semiconductor laser of a ridge mold, it is not restricted to sapphire, and is carbonization silicon (SiC). A substrate may be used and it is drawing 1 (b) about the example. It bases and explains.
[0006] first, SiC a substrate 121 top -- MOVPE -- law -- n mold AlGaN A cladding layer 122, the n mold GaN SCH layer 123, and InGaN A barrier layer 124, the p-

mold GaN SCH layer 125, and p mold AlGaN A cladding layer 126 and p mold GaN The contact layer 127 is formed in order. Then, after forming stripe-like SiO2 film (un-illustrating) on the contact layer 127, the SiO2 film is used as a mask and the well-known dry etching method is used, and they are the p mold GaN contact layer 127 and the p mold AlGaN. A cladding layer 126 is removed in order alternatively, and, thereby, the p mold GaN SCH layer 125 is exposed from the both sides of a stripe-like SiO2 film.

[0007] Furthermore, after removing SiO2 film, SiO2 still more nearly another film 128 is formed, patterning of this is carried out using the well-known photolithography method, and contact hole 128a is formed on the contact layer 127. Then, the p lateral electrode 129 is formed on the contact layer 127 through contact hole 128a, and it is SiC further. The n lateral electrode 130 is formed in the bottom of a substrate 121.

[0008] Thereby, it is SiC. GaN of the ridge mold used as the substrate The basic structure of a system semiconductor laser diode is completed. such -- SiC Since the semiconductor laser using a substrate can expect the effect of a heat sink and can prepare n lateral electrodes in a substrate side compared with the semiconductor laser which used silicon on sapphire, the same chip mounting technology as the usual semiconductor laser etc. can be used for it. Furthermore, SiC Since the semiconductor laser using a substrate can give cleavability by choosing field bearing of a substrate suitably, it becomes possible to create the Fabry-Perot reflector easily compared with the semiconductor laser using silicon on sapphire.

[0009]

[Problem(s) to be Solved by the Invention] The conventional III In the semiconductor laser using a group nitride compound semiconductor, ridge structure needed to be adopted, the electrode needed to be formed on the ridge, and the width of face of a ridge was restricted by the area of an electrode from the need of securing the margin of the alignment of an electrode. When the width of face of the ridge was set to 2 micrometers or more, there was a problem that lateral optical confinement was weak and the shape of beam became oblong.

[0010] The method of shining and closing, without taking ridge structure and performing eye ** or the semiconductor laser which forms a current constriction layer is indicated by JP,10-294529,A, JP,9-232680,A, and JP,8-88441,A. Although confining light in JP,10-294529,A using a refractive-index difference by forming an optical confinement layer in the side of the ridge on p mold cladding layer is indicated, it is InGaN with a bigger refractive index than p mold cladding layer as a material of an optical confinement layer. Using is shown. According to the material with such a big refractive index, there is un-arranging [of being easy to leave the higher mode].

[0011] Moreover, the material is InGaN although the example in which the current blocking layer was formed into p mold cladding layer is indicated by JP,8-97502,A. It is silicon etc., and it is characterized by using a light absorption material, and control of the transverse mode is not fully made. And if dry etching is used for the photolithography method since the photolithography method is used in order to form a current path in the current blocking layer, an etching damage will be given to a part for the light-emitting part of the barrier layer of the lower part, and a luminescence property will be worsened.

[0012] Furthermore, in JP,9-232680,A, it is AlN as a current constriction layer. Although the example using a layer is indicated, it is AlN about the both sides of the

ridge of a cladding layer. It has structure embedded in a layer and is drawing 1 (b). In order to secure a contact field with p lateral electrode similarly with having been shown, the width of face of a cladding layer must be expanded. And the AlN It is the same as a cladding layer, or it is more than it, and is as thick as 1 micrometer, optical confinement becomes strong too much, and the thickness of a layer tends to leave the higher mode.

[0013] Moreover, in JP,8-88441,A, it is AlN as a current constriction layer between p mold cladding layer and p mold contact layer. Although the example in which the layer was formed is indicated, transverse-mode control is not performed effectively. The purpose of this invention is to offer the manufacture method of semiconductor luminescence equipment with easy controlling the transverse mode to desired width of face, and semiconductor luminescence equipment including the production process which does not give a damage to the current path of a barrier layer in case a transverse-mode control structure is formed while taking the arbitrarily and large contact to an electrode.

[0014]

[Means for Solving the Problem] (1) It is inserted into a 1 conductivity-type cladding layer and an opposite conductivity-type cladding layer, and the above-mentioned technical problem is III. A barrier layer barrier layer which consists of a group nitride, The inside of one [at least] cladding layer of said 1 conductivity-type cladding layer or said opposite conductivity-type cladding layer, Or between one [at least] cladding layer of said 1 conductivity-type cladding layer or said opposite conductivity-type cladding layer, and a barrier layer AlN which has thickness of 300nm or less more greatly than 0 formed from -- it is solved by the semiconductor luminescence equipment characterized by having a becoming transverse-mode control layer.

[0015] Or it is AlN to the production process which forms a stripe-like mask layer on a substrate, and the substrate surface containing said mask layer. Said AlN formed in a side wall and the upper surface of said mask layer while having etched said mask layer using a production process which forms a layer, and a solution which can etch said mask layer It is solved by the manufacture method of the semiconductor luminescence equipment characterized by to have a production process which carries out lift off of the layer. In this case, said AlN A layer may be formed at substrate temperature of 500 degrees C or less by spatter.

(2) AlN which the above-mentioned technical problem was formed in a current constriction field in an up cladding layer and a lower cladding layer which bandgap energy consists of a large gallium nitride system compound semiconductor from a barrier layer which consists of a gallium nitride system compound semiconductor, and said barrier layer, and sandwich said barrier layer, and said up cladding layer, and has started on both sides of a current passage field Or AlGaN Or GaN from -- it is solved by the semiconductor luminescence equipment characterized by to have a becoming insulating layer.

[0016] An up cladding layer and a lower cladding layer which the above-mentioned technical problem consists of a gallium nitride system compound semiconductor with large bandgap energy from a barrier layer which consists of a gallium nitride system compound semiconductor, and said barrier layer, and sandwich said barrier layer, AlN which is formed in a current constriction field in said up cladding layer, and has a opening to a current passage field Or AlGaN Or GaN from -- with a becoming insulating layer for current constrictions It is solved by the semiconductor

luminescence equipment characterized by having a high resistance field where an impurity of said up cladding layer of said insulating-layer bottom was inactivated. In this case, hydrogen, nitrogen, and an argon are introduced into said high resistance field. Moreover, you may make it said insulating layer start on both sides of said current passage field.

[0017] A production process at which the above-mentioned technical problem forms a 1 conductivity-type cladding layer on a substrate, A production process which forms a barrier layer on said 1st conductivity-type cladding layer, and a production process which forms the 1st opposite conductivity-type cladding layer on said barrier layer, A production process which forms a stripe-like mask on said 1st opposite conductivity-type cladding layer, A production process which carries out dry etching of the field which is not covered with said mask, and forms the mesa section in said 1st opposite conductivity-type cladding layer at least, It is AlN on said mask and said 1st reverse conductivity-type cladding layer. Or AlGaN Or GaN A production process which forms a becoming insulating layer, A production process which also removes said insulating layer on said mask by removing said mask, It is solved by the manufacture method of semiconductor luminescence equipment characterized by having with a production process which forms the 2nd opposite conductivity-type cladding layer and contact layer on said insulating layer and said 1st opposite conductivity-type cladding layer.

[0018] A production process at which the above-mentioned technical problem forms a 1 conductivity-type cladding layer on a substrate, A production process which forms a barrier layer on said 1st conductivity-type cladding layer, and a production process which forms the 1st opposite conductivity-type cladding layer on said barrier layer, A production process which forms a stripe-like mask on said 1st opposite conductivity-type cladding layer, It is AlN on said mask and said 1st opposite conductivity-type cladding layer. Or AlGaN Or GaN A production process which forms a becoming insulating layer, A production process which introduces hydrogen, nitrogen, or an argon into said 1st opposite conductivity-type cladding layer of a field which is not covered with said mask from the outside, and forms a high resistive layer, A production process which also removes said insulating layer on said mask by removing said mask, It is solved by the manufacture method of semiconductor luminescence equipment characterized by having a production process which forms the 2nd opposite conductivity-type cladding layer and contact layer on said insulating layer and said 1st opposite conductivity-type cladding layer. In this case, you may make it have further a production process which carries out dry etching of the field which is not covered with said mask, and forms the mesa section in said 1st opposite conductivity-type cladding layer at least.

[0019] Next, an operation of this invention is explained. according to this invention -- III inside of a cladding layer formed on a barrier layer which consists of a group nitride, or in the bottom -- as a transverse-mode control layer -- 0nm -- large -- coming out -- AlN with a thickness of 300nm or less A layer is inserted. The transverse-mode control layer functions also as a current constriction layer. AlN A layer is AlGaN. Compared with a layer, a refractive-index difference with a cladding layer can be made small, and the higher mode cannot pass easily. And AlN Another mode oscillation can be prevented by attaining an oscillation of a basic mode and setting 0nm or more of thickness of a layer to 300nm or less by making it 1nm or more preferably. Furthermore, AlN When a layer is set to 300nm or less, it is also expected that generating of a crack will be controlled.

[0020] The AlN A layer is AlN, without reducing clad layer thickness of on a barrier layer or the bottom, since it is formed in a cladding layer of p mold or n mold. The current constriction only of the layer can be brought close and carried out to a barrier layer, and the necessity of narrowing width of face of an electrode it not only can aim at reduction of a threshold current, but formed above a cladding layer is lost. Moreover, after forming a mask on a cladding layer according to this invention, it is AlN on a cladding layer and a mask. It is AlN by forming a transverse-mode control layer and subsequently removing a mask. Since a opening used as a current path was formed in a transverse-mode control layer, it is AlN. In case a layer is formed, a barrier layer is protected by mask and a damage does not go into a barrier layer with it. And AlN Since wet etching of the layer has not been carried out, width of face of the opening is controlled and it does not spread too much.
[0021] Furthermore, since structure where the side of a opening was started among transverse-mode control layers formed in the above-mentioned cladding layer was adopted according to this invention, in case a transverse-mode control layer is formed, a luminescence field of a barrier layer is protected by thick cladding layer. And on both sides of a luminescence field, since an optical confinement layer is approaching a barrier layer, transverse-mode control is made good, and breadth of current within a cladding layer is controlled, and a threshold current decreases.
[0022] In this invention, since a high resistive layer was further formed in the bottom of a transverse-mode control layer, breadth of current within a cladding layer is controlled further, and a threshold current decreases more. Furthermore, in order to form the mesa section in a cladding layer on the barrier layer, when a method of carrying out dry etching of the cladding layer is adopted, there is much more current constriction effect.
[0023]
[Embodiment of the Invention] Then, the operation gestalt of this invention is explained based on a drawing below.
(Gestalt of the 1st operation) Drawing 2 (a) It is a cross section explaining invention concerning the 1st viewpoint of this invention. Drawing 2 (a) It sets and is SiC. On a substrate 1, it is the n mold AlGaN. A cladding layer 2, the n mold GaNSCH layer 3, and undoping InGaN A barrier layer 4, the p mold GaN SCH layer 5, and 1st p mold AlGaN The cladding layer 6 is formed in order. Moreover, 1st p mold AlGaN AlN which has stripe-like opening 7a on a cladding layer 6 The transverse-mode control layer 7 is formed. Furthermore, p mold AlGaN exposed from opening 7a A cladding layer 6 top and AlN On the transverse-mode control layer 7, it is the 2nd p mold AlGaN. A cladding layer 8 is formed and it is the p mold GaN on the p mold AlGaN cladding layer 8. The contact layer 9 is formed.
[0024] SiC each class on a substrate 1 -- MOVPE -- it is formed at 3 times of crystal growth production processes of law etc. In addition, p lateral electrode 10p is formed on the contact layer 9, and it is SiC. 10n of n lateral electrodes is formed in the bottom of a substrate 1. Drawing 2 (b) It sets and is SiC. On a substrate 11, it is the 1st n mold AlGaN. A cladding layer 12 and AlN The transverse-mode control layer 13 is formed in order, and it is the AlN. Stripe-like opening 13a is formed in the transverse-mode control layer 13. The AlN The transverse-mode control-layer 13 top and in opening 13a, it is the 2nd n mold AlGaN. A cladding layer 14 is formed and it is the 2nd n mold AlGaN. On a cladding layer 14, it is InGaN of the n mold GaN SCH layer 15 and undoping. A barrier layer 16, the p mold GaN SCH

layer 17, and p mold AlGaN The cladding layer 18 and the p mold GaN contact layer 19 are formed in order.

[0025] SiC each class on a substrate 11 -- MOVPE -- it is formed at 3 times of crystal growth production processes of law etc. In addition, p lateral electrode 20p is formed on the contact layer 19, and it is SiC. 20n of n lateral electrodes is formed in the bottom of a substrate 11. Drawing 2 (a) and (b) AlN which has the openings 7a and 13a prolonged in the shape of a stripe as shown It is AlN if the transverse-mode control layers 7 and 13 are inserted into p mold or n mold cladding layers 6, 8, and 21, and 14. Since a refractive-index difference arises in the transverse-mode layers 7 and 13 and cladding layers 6, 8, 21, and 14, it becomes possible to confine light in the location corresponding to a stripe.

[0026] Therefore, it is AlN, without taking ridge structure. Since a locked-in effect is obtained by the transverse-mode control layers 7 and 13, it is this AlN. It becomes possible to control the transverse mode by choosing the gap of the transverse-mode control layers 7 and 13 as arbitration to desired width of face, though it is possible to enlarge contact to the p lateral electrodes 10a and 20a. At this time, it is AlN. Thickness of the transverse-mode control layers 7 and 13 is made into 300nm or less degree more greatly than 0nm. This is because multimode oscillation can be prevented by the oscillation of a basic mode being attained and setting thickness to 300nm or less by it being larger than 0nm and making it 1nm or more preferably. In addition, it is AlN by making thickness into such a range. The effect of controlling generating of the crack of the transverse-mode control layers 7 and 13 is also expectable.

[0027] AlN The transverse-mode control layers 7 and 13 are drawing 2 (a) and (b). Although it is effective and is not shown in drawing p molds even if it inserts between which cladding layers n molds so that it may be shown, you may insert in both layers. When it inserts in the cladding layer of both by the side of p and n, the aspect ratio of the shape of beam can be brought close to 1, and it becomes what was suitable as the light source of an optical disk etc.

[0028] and drawing 2 (a) it is shown -- as -- AlN Since the carrier which could also expect the effect which is a current constriction and was poured in from p side appearance 10p stops spreading in the barrier layer 4 neighborhood when the transverse-mode control layer 7 is formed among p mold cladding layers 6 and 8, it is effective in reducing a threshold current. Drawing 3 (a) and (b) Drawing 2 (a) and (b) Shown AlN Formation of the transverse-mode control layers 7 and 13 and formation of Openings 7a and 13a are shown.

[0029] First, drawing 3 (a) The mask 21 of the shape of a stripe formed from SiO2 etc. is formed on the cladding layer 6 (12) on a substrate 1 (11) so that it may be shown. Then, AlN which constitutes the transverse-mode control layer 7 (13) on the whole surface so that the stripe-like mask 21 and the level difference of a cladding layer 6 (12) may be covered A layer 22 is grown up by the MOVPE method, an ECR spatter, etc. In this case, it is AlN so that it may be thin in the lateral portion of a mask 21 and may become thick on each upper surface of a cladding layer 21 and a mask 21. A layer 22 is formed.

[0030] Therefore, if a mask 21 is dipped in the solution for etching a mask 21, for example, fluoric acid, it is thin AlN on the side of a mask 21. Lift off of layer 22a and the thick AlN layer 22b on the mask upper surface is carried out, and it is AlN only on a cladding layer 6 (12). Layer 22c remains and it is the AlN. Layer 22c is used as a transverse-mode control layer 7 (13). The thickness of a mask 21 is AlN.

If there is 1.5 or more-time thickness of a layer 22, it will be AlN thin in the upper part of the side wall of a mask 21. It is AlN in the upper part of a side wall by making the thick-film ratio larger than 5 times, although layer 22a is formed. Layer 22a can be made sufficiently thin and the linearity of the edge of opening 22a (7a, 13a) of a stripe can be improved.

[0031] Furthermore, AlN It is AlN by setting preferably to less than 300 micrometers the gap (aperture width) of the field which removes a layer 22 less than 1mm. The stress in a film 22 is distributed and it is AlN. Generating of the crack of a film 22 can be controlled. If the formation production process of the above transverse-mode control layers is adopted, right above [of the light-emitting part of barrier layers 4 and 16] or directly under can prevent being in the condition of having been protected with the mask 21, not putting a light-emitting part to a plasma ambient atmosphere in subsequent etching or layer growth, and a damage going into a light-emitting part.

[0032] By the way, AlN When forming stripe-like opening 22a in a layer 22, and the usual photolithography method is used, there are the following problems. That is, a phosphoric acid is used in the case of photolithography, and it is AlN. It is AlN if a layer is etched. It compares in the direction of a c-axis, and since the direction of an a-axis is larger, the etching rate to the phosphoric acid of a layer is AlN. The amount of side etching of a layer becomes large, and control of the width of face of opening 22a becomes difficult. Moreover, the dry etching method is used and it is AlN. If a layer is etched and a opening is formed, in order that dry etching of right above [of barrier layers 4 and 16] or directly under will be carried out and the effect of an etching damage may attain to even the light-emitting part of barrier layers 4 and 16, the problem which says a luminescence property if the worst happens arises.

[0033] Moreover, GaN It is Alx Ga1-x N as a cladding layer of system semiconductor laser. Although it is generally used by 0< x<=0.2 when using, it is such Alx Ga1-x N. If an AlN layer is grown up on a layer, it is AlN by the grid mismatch. A tensile stress strong against a layer is applied and the problem that a crack occurs arises. Those problems are solved by the patterning method which was described above.

[0034] Next, AlN which was described above The production process which forms semiconductor laser using the patterning method of a layer is explained. First, drawing 4 (a) It is 6 H-SiC so that it may be shown. On the field (0001) of the becoming substrate 31 The MOVPE method is used. n mold AlGaN Becoming n mold cladding layer 32 and the n mold GaN The becoming n mold SCH layer 33 and undoping InGaN The becoming barrier layer 34, p mold optical confinement layer 35 which consists of a p mold GaN, and p mold AlGaN 1st becoming p mold cladding layer 36, respectively 1500nm, It forms in the thickness of 100nm, 10nm, 100nm, and 50nm in order.

[0035] Next, after forming SiO2 film 37 with a heat CVD method on 1st p mold cladding layer 36 at the thickness of 5-2000nm, it is drawing 4 (b). Patterning of the SiO2 film 37 is carried out by the photolithography method, and it leaves with a width of face of 0.1-2 micrometers in the shape of a stripe so that it may be shown. In this case, although not illustrated especially, two or more pitches of the stripe-like SiO2 film 37 are formed as 10-1000 micrometers.

[0036] after [furthermore,] pure water washes SiO2 film 37 grade -- a substrate 31 -- room temperature - the condition preferably heated in temperature of 100 degrees C - 400 degrees C 500 degrees C -- it is -- drawing 5 (a) it is shown -- as -- the 1st p

mold cladding layer 36, and stripe-like SiO2 film 37 top -- AlN By the ECR spatter, it is larger than 0nm, and is 1nm or more preferably, and a layer 38 is formed in the thickness of 300nm or less.

[0037] Then, drawing 5 (b) While SiO2 film 37 will be removed if a substrate 31 and each class on it are dipped in a fluoric acid solution for [30 seconds -] 5 minutes so that it may be shown, it is AlN on SiO2 film 37. Lift off of the layer 38 is carried out, and it is AlN. With a width of face of 1-2 micrometers opening 38w is formed in a layer 38. AlN which has the opening A layer 38 is used as transverse-mode control-layer 38a. The lift off may be made in the case of pure water washing after hydrofluoric acid treatment, or ultrasonic cleaning.

[0038] In addition, AlN by which lift off is carried out Layers 38 are the thin portion of the flank of SiO2 film 37, and a thick portion on the upper surface. next, drawing 6 (a) it is shown -- as -- a transverse-mode control-layer 38a top and the inside of opening 38w -- p mold AlGaN with a thickness of 500nm 2nd becoming p mold cladding layer 39 and p mold GaN with a thickness of 50nm the becoming contact layer 40 -- MOVPE -- it forms in order by law.

[0039] Furthermore, drawing 6 (b) Nickel gold (NiAu) is formed on the contact layer 40 with vacuum deposition as a p lateral electrode 30, and titanium aluminum (TiAl) is further formed in the inferior surface of tongue of a substrate 41 with vacuum deposition as an n lateral electrode 29 so that it may be shown. After that, cleavage of a substrate 31 and each semiconductor layer on it is perpendicularly carried out to the extension direction of opening 38w, and this creates a resonator. Furthermore, laser equipment is completed through chip separation and a bonding production process.

[0040] It sets to such semiconductor laser and is AlN. Since transverse-mode control-layer 38a is formed in the thickness of 300nm or less by 0nm or more, while lateral optical confinement is made effectively and the transverse mode is controlled, generating of the higher mode is prevented. Moreover, AlN Since patterning of the transverse-mode control-layer 38a is carried out by the lift-off method, the damage to the barrier layer produced by using the dry etching method and its near can be prevented beforehand. Moreover, AlN produced by using the wet etching method Rapid side etching of a layer 38 can be prevented and the size of opening 38w can be formed with a sufficient precision.

[0041] furthermore, AlN since the layer 38 is formed by the ECR spatter -- MOVPE -- while suppressing substrate temperature at low temperature 500 degrees C or less compared with the case where it forms by law -- AlN AlN by carrying out single crystal growth of the layer 38, can prevent the heat deterioration of a barrier layer 34, and according to a coefficient-of-thermal-expansion difference with a substrate layer in ** The crack initiation of a layer 38 can be stopped.

[0042] In addition, it is AlN by the spatter. When forming a layer 38, a substrate 31 will be put to the plasma, but since the mask 37 for lift off (SiO two-layer) is formed in right above or the location [directly under] of a light-emitting part of a barrier layer 38, the mask 37 serves as a protective coat of a barrier layer 34, and generating of a damage is prevented. Moreover, it is AlN although the ECR spatter was used as an example of a spatter. The usual spatter used as a target, the reactive ion spattering method which carries out a spatter using nitrogen gas by using aluminum as a target may use other spatters.

[0043] Next, AlN Another example of the lift-off method used when carrying out patterning of the layer 38 is explained. Drawing 7 (a) and (b) It is a perspective

diagram explaining another example of the lift-off method, and the same sign as drawing 3 - drawing 6 shows the same element. It sets for this example and is drawing 4 (b). A different point is having made the cross-section configuration of a stripe-like SiO2 film into the reverse mesa configuration.

[0044] First, drawing 7 (a) On 1st p mold cladding layer 36, with a heat CVD method, SiO2 film 27 is formed at the thickness of 2-800nm so that the Lynn concentration may fall toward a top from the bottom, then a resist (un-illustrating) is used as a mask, and it leaves the SiO2 film 27 in the shape of a stripe using a fluoric acid solution so that it may be shown. In addition, a silane and the mixed gas of water are used as source gas for forming SiO2 film 27, and it is HOFUFIN (PH3) as source gas of Lynn. It is used.

[0045] It is known that the etching rate to the fluoric acid solution of SiO2 film 27 will be dependent on the concentration of impurities, such as Lynn. Therefore, since it becomes early so that an etching rate [as opposed to / when it forms with a CVD method so that the Lynn concentration may become low as Lynn concentration of the lower layer section is made high among SiO2 films 27 and it goes to the upper layer / a fluoric acid solution] turns down, stripe-like SiO2 film 27 becomes reverse mesa-like.

[0046] And after removing a resist, it is drawing 7 (b). It is AlN so that it may be shown. It is larger than 0nm and is 1nm or more preferably, and a layer 38 is formed by the ECR spatter so that it may become the thickness of 300nm or less. In this case, since it is a reverse mesa, the stripe-like SiO2 film 27 is AlN. The thickness of a layer 38 becomes very thin by the side wall of SiO2 film 27, and is AlN on SiO2 film 28. The lift off of a layer 38 becomes easy.

[0047] therefore, AlN the thickness of a layer 38 -- comparing -- SiO two-layer -- lift off becomes possible even if it does not make thickness of 27 so thick. In addition, in the above-mentioned example, the etching rate of SiO2 film 27 was changed by changing the Lynn concentration in SiO2 film 27 in the thickness direction. In addition, it is also possible by using a SiON film instead of SiO2, and changing the nitrogen concentration in the direction of thickness to change an etching rate in the direction of thickness. In this case, if the content of nitrogen is made [many] as growth of a SiON film progresses since the etching rate by fluoric acid becomes small so that there are many contents of nitrogen, the cross section after forming a SiON film in the shape of a stripe by the photolithography method will become a reverse stripe configuration. In addition, the mixed gas of a silane, ammonium, and oxygen is used as source gas of a SiON film.

[0048] next, still more nearly another example of the lift-off method -- drawing 8 (a) and (b) It bases and explains. It sets for this example and is drawing 7 (a). (b) A different point is having used the cross-section configuration of a stripe-like SiO2 film as T mold. First, on 1st p mold cladding layer 36, 1st SiO2 film 25a is formed in the thickness of 1-400nm by the spatter, it continues and 2nd SiO2 film 25b is formed with a heat CVD method on 1st SiO2 film 25a at the thickness of 1-400nm.

[0049] Next, a stripe-like resist (un-illustrating) is used as a mask, SiO2 films 25a and 25b are etched with a fluoric acid system solution, and the resist is removed after that. In this case, since the etching rate to a fluoric acid system solution is large compared with 2nd SiO2 film 25b formed with the CVD method, 1st SiO2 film 25a formed by the spatter is drawing 8 (a). A cross section can acquire the configuration of a T character mold so that it may be shown. The mask 25 for lift off is formed with the 1st and 2nd SiO2 films 25a and 25b formed by this.

[0050] Then, drawing 8 (b) It is AlN so that it may be shown. If it is larger than 0nm, it is 1nm or more preferably and a layer 38 is formed in the thickness of 300nm or less by the ECR spatter, at the flank of the mask 25 for lift off of a cross-section the mold of T characters, it is AlN. A layer 38 becomes very thin and the lift off on the mask 25 for lift off becomes easy. In addition, although the formation method of SiO2 films 25a and 25b was changed and the etching rate of the upper part of the mask for lift off and the lower part was changed in this example, they are SiO2 film and SiN in changing the Lynn concentration in the lower layer and the upper layer of SiO2 film ****. You may make it the direction of a lower layer [etching rate / to etchant] become large by forming a film.

[0051] in addition -- the above-mentioned operation gestalt -- AlN although the layer 38 was formed by the ECR spatter -- heat treatment -- if allowed conditional -- MOVPE -- you may form using law. Moreover, with the above-mentioned operation gestalt, although the transverse-mode control layer was formed into the cladding layer, even if it inserts between a SCH layer and a cladding layer, the same effect may be acquired, it is not p mold cladding layer side, and it may form in n mold cladding layer side, or you may form in these both sides. furthermore, the inside of a SCH layer -- or the same effect is acquired even if it inserts between a SCH layer and a barrier layer.

[0052] At the above-mentioned example, it is InGaN as a barrier layer. They are other III(s) although the layer is used. A group nitriding compound may be used and not a monolayer but multilayer quantum well structure may be used. Furthermore, at the above-mentioned example, it is III as an III-V group compound. It is AlN although the example using a group nitriding compound was shown. It is possible to apply this invention about other III-V group compounds using a layer.

(Gestalt of the 2nd operation) It sets in the gestalt of the 1st operation and they are a barrier layer and AlN. The cladding layer is formed between transverse-mode control layers. The AlN It is AlN if the distance of a transverse-mode control layer and a barrier layer, i.e., clad layer thickness, is set to 0.1 micrometers or more. The current which passes along the opening of a transverse-mode control layer spreads horizontally in a cladding layer, and becomes the cause by which the threshold current of semiconductor laser increases. To the contrary, it is AlN. It is AlN if the cladding layer between a transverse-mode control layer and a barrier layer is formed thinly. In giving a damage to a barrier layer at the time of formation of a transverse-mode control layer ****, it is AlN. Membrane formation cannot control well but it is AlN. There is a possibility that the surface morphology of a transverse-mode control layer may deteriorate.

[0053] So, this operation gestalt explains the semiconductor laser which can perform transverse-mode control, without increasing a threshold current, and its manufacture method. First, drawing 9 (a) The MOCVD method is used so that it may be shown, and it is n mold carbonization silicon (SiC). On the field (0001) of a substrate 41 n mold (n-) aluminum0.09Ga0.91N with a thickness of 1.5 micrometers n-GaN with a cladding layer [42] and a thickness of 100nm The SCH layer 43 and Undoping InGaN The multiplex quantum well (MQW) barrier layer 44 and p mold (p-) aluminum0.18Ga0.82N with a thickness of 20nm Are larger than 0 micrometer in the electron block layer 45, the p-GaN SCH layer 46 with a thickness of 100nm, and thickness. 1st p-aluminum0.09Ga0.91N 5 micrometers or less A cladding layer 47 is grown up in order, respectively.

[0054] The multiplex quantum well barrier layers 44 are four In0.03Ga0.97Ns. It is

In0.15Ga0.85N between each of a barrier layer. It has the structure whose well layer was pinched. The barrier layer is 5nm and a well layer is 4nm in thickness. Next, 1st p-aluminum0.09Ga0.91N SiO2 film 48 is formed with a heat CVD method on a cladding layer 47 at the thickness of 300nm. Then, drawing 9 (b) Patterning of the SiO2 film is carried out to width of face of 0.5-2.0 micrometers, for example, the stripe configuration of 1.5 micrometers, by the photolithography method, and this is used as a mask 48 so that it may be shown.

[0055] 1st p-aluminum0.09Ga0.91N of the field which is not covered with a mask 48 after that A cladding layer 47 is etched. This etching is drawing 9 (c). It is 1st p-aluminum0.09Ga0.91N so that it may be shown. You may go to the depth in which a part of cladding layer 47 remains, for example, 0.2 micrometers, or it is n-aluminum0.09Ga0.91N. You may carry out to the depth which reaches a cladding layer 42, or it is 1st p-aluminum0.09Ga0.91N. A cladding layer 47 and n-aluminum0.09Ga0.91N You may carry out to the depth between cladding layers 42.

[0056] Since the luminescence field of a barrier layer 44 is protected by the mask 48 in the case of the etching, it is 1st p-aluminum0.09Ga0.91N. Especially a problem does not have a damage in a barrier layer 44 etc. as close on both sides of a mask 48 by etching of a cladding layer 47. By the etching, it is 1st p-aluminum0.09Ga0.91N under a mask 48. Mesa section 47a of a cladding layer 47 is formed, and the upper surface of the mesa section 47a becomes a stripe configuration with a width of face of 0.5-2.0 micrometers.

[0057] Next, drawing 10 (a) An ECR spatter is used so that it may be shown, and they are a mask 48 and 1st p-aluminum0.09Ga0.91N. AlN of insulation [top / cladding layer 47] A layer 49 is formed in the thickness of 20nm. Then, it is AlN on a mask 48 by etching the mask 48 on mesa section 47a by fluoric acid. AlN which carried out lift off of the layer 49, and remained in the side of mesa section 47a A layer 49 is used as a transverse-mode control layer. Thereby, it is drawing 10 (b). The upper surface of mesa section 47a is AlN so that it may be shown. It exposes from a layer 49 and is AlN. The opening for current passage is formed in a layer 49, and it is AlN. A layer 49 will be started along the side of mesa section 47a. The maximum angle to the upper surface of a barrier layer 44 is more greatly [than 30 degrees] smaller than 150 degrees among the portions which have started. AlN The angle to the barrier layer 44 of the standup portion of a layer 49 changes with locations.

[0058] Next, 2nd crystal growth is performed by the MOCVD method. Namely, drawing 10 (c) It is AlN so that it may be shown. To a layer 49 and the upper surface of mesa section 47a, it is 2nd p-aluminum0.09Ga0.91N. A cladding layer 50 and p-GaN The contact layer 51 is formed in the thickness of 10nm - 3000nm (for example, 700nm) and 0.05 micrometers, respectively. In this case, a cladding layer 50 and the contact layer 51 are AlN. Crystal growth is carried out on a layer 49.

[0059] In addition, AlN Instead of a layer 49, they are insulating AlGaN and GaN. Or Si3N4 You may grow up by MOCVD and ECR and the cladding layer 50 formed on the film crystallizes one of layers. After that, as shown in drawing 11 , on the contact layer 51, the insulator layer 52 which consists of SiO2 is formed, patterning of this is carried out by the photolithography method, and opening 52a is formed above mesa section 47a. After that, the p lateral electrode 53 connected to the contact layer 51 is formed on the insulator layer 52 of the inside of opening 52a, and the circumference of it.

[0060] Furthermore, SiC The n lateral electrode 53 is formed in the bottom of a

substrate 41. In addition, the p lateral electrode 53 may be formed on the contact layer 51, without passing through the production process which forms an insulating layer on the contact layer 51. In this case, the current supplied to the contact layer 51 is AlN. A current constriction is carried out by only the layer 49. The fundamental structure of semiconductor laser is completed by the above.

[0061] After forming the 1st cladding layer 47 above a barrier layer 44, while reducing the thickness of the 1st cladding layer 47 in the field by etching the 1st cladding layer 47 of the both sides of a luminescence field, he is trying to form mesa section 47a on a luminescence field at a production process which was described above. Therefore, even if it forms thickly the 1st cladding layer 47 on the luminescence field of a barrier layer 44, the flowing current breadth-comes to be hard of mesa section 47a on the both sides, and reduction of the threshold of semiconductor laser is attained. The continuous line a of drawing 12 shows the current and the output characteristics of the semiconductor laser of this operation gestalt, and the dashed line b of drawing 12 shows the current and the output characteristics of the semiconductor laser of the 1st operation gestalt. In drawing 12 , the threshold of the semiconductor laser of this operation gestalt is as **** smaller than the threshold of the semiconductor laser of the 1st operation gestalt.

[0062] Moreover, since the 1st cladding layer 47 on a luminescence field is thick, it is AlN by ECR on it. It is lost and it is the AlN to give a damage to the barrier layer 44 of a luminescence field, when forming a layer 49. Control of membrane formation of a layer 49 becomes easy, and surface morphology stops deteriorating. Furthermore, at this operation gestalt, it is AlN like the 1st operation gestalt. Since the constriction of the current is carried out by the layer 49, contact area of the top electrode 53 and the contact layer 51 can be enlarged, contact resistance can be reduced, and, thereby, element resistance can be lowered.

[0063] In addition, the above-mentioned SiC They are silicon on sapphire and GaN instead of a substrate. A substrate etc. may be used. Moreover, for the presentation of a buffer and a clad, thickness and the presentation of a barrier layer, thickness, a well number of layers, etc., those layers are AlGaInN. If it is the material of a system, it will not be limited to the above-mentioned configuration. Furthermore, the material of a mask 48 is not limited to SiO2, and may use the insulator layer of SiON and others.

(Gestalt of the 3rd operation) Drawing 13 - drawing 15 are the cross sections showing the formation production process of the semiconductor laser concerning the gestalt of the 3rd operation.

[0064] First, drawing 13 (a) The MOCVD method is used so that it may be shown, and it is n mold carbonization silicon (SiC). On the field (0001) of a substrate 41, it is n-aluminum0.09Ga0.91N. A cladding layer 42, the n-GaN SCH layer 43, the nGaN multiplex quantum well (MQW) barrier layer 44, and p-aluminum0.18Ga0.82N The electron block layer 45, the p-GaN SCH layer 46, and 1st p-aluminum0.09Ga0.91N A cladding layer 47 is grown up in order, respectively. The thickness of those layers and a presentation are made the same as for example, the 2nd operation gestalt.

[0065] Next, 1st p-aluminum0.09Ga0.91N The stripe-like mask 48 is formed on a cladding layer 47. The mask 48 has a stripe configuration with a width of face of 0.5-2.0 micrometers, and consists of SiO2 films with a thickness of 300nm. Patterning of the mask 48 is carried out by the method shown in the 2nd operation gestalt. Furthermore, the layer of the field which is not covered with a mask 48 is

etched. The depth of etching is drawing 13 (c). It is made to be the same as that of the 1st operation gestalt so that it may be shown. By the etching, it is 1st p-aluminum0.09Ga0.91N under a mask 48. Mesa section 47a of a cladding layer 47 is formed.

[0066] Since the luminescence field of a barrier layer 44 is protected by the mask 48 in the case of this etching, a damage does not enter in that field. Next, drawing 14 (a) It is 1st p-aluminum0.09Ga0.91N at the both sides of a mask 48 by pouring a hydrogen ion into the both sides of a mask 48, or diffusing hydrogen so that it may be shown. The acceptor of a cladding layer 47 is inactivated and high resistive layer 47b is formed there. High resistive layer 47b is drawing 14 (a). It is 1st p-aluminum0.09Ga0.91N so that it may be shown. It is formed only into a cladding layer 47, **** is also good, and it is n-aluminum0.09Ga0.91N. It may be formed in the depth which reaches even a cladding layer 42.

[0067] When forming the high resistive layer 47b, it is 1st p-aluminum0.09Ga0.91N. From the upper surface of a cladding layer 47, the element poured in or diffused may not be restricted to hydrogen, and may be nitrogen, an argon, etc. Moreover, as the method of diffusion of the element, diffusion of the ion by annealing or ECR equipment in the inside of the ambient atmosphere containing the element is mentioned.

[0068] After that, it is drawing 14 (b). An ECR spatter is used so that it may be shown, and they are a mask 48 and 1st p-aluminum0.09Ga0.91N. On a cladding layer 47 and high resistive layer 47b, the insulating AlN layer 49 is formed at the thickness of 20nm. Then, it is AlN on a mask 48 by etching the mask 48 on mesa section 47a by fluoric acid. Lift off of the layer 49 is carried out. Thereby, it is AlN as shown in drawing 14 (c). A layer 49 remains along the side of mesa section 47a, and is AlN. A opening is formed on mesa section 47a at a layer 49.

[0069] Next, 2nd crystal growth is performed by the MOCVD method. Namely, drawing 15 (a) It is AlN so that it may be shown. On a layer 49 and mesa section 47a, it is 2nd p-aluminum0.09Ga0.91N. A cladding layer 50 and p-GaN The contact layer 51 is formed in the thickness of 0.7 micrometers and 0.05 micrometers, respectively. In this case, not only a mesa section 47a top but AlN Also on a layer 49, crystal growth of a cladding layer 50 and the contact layer 51 is carried out. In addition, AlN Instead of a layer 49, they are insulating AlGaN and GaN. Or Si3N4 You may grow up by MOCVD and ECR and the cladding layer 50 formed on the film crystallizes one of layers.

[0070] After that, it is drawing 15 (b). The insulator layer 52 which consists of SiO2 is formed on the contact layer 51, patterning of this is carried out by the photolithography method, and opening 52a is formed on mesa section 47a so that it may be shown. After that, the p lateral electrode 53 connected to the contact layer 51 is formed on the insulator layer 52 of the inside of opening 52a, and the circumference of it. Furthermore, SiC The n lateral electrode 53 is formed in the bottom of a substrate 41.

[0071] Blue luminescence semiconductor laser is completed according to the above production process. According to the semiconductor laser mentioned above, like the semiconductor laser of the 2nd operation gestalt, deterioration of the surface morphology of the AlN layer 49 is controlled, deterioration of the barrier layer 44 of a luminescence field is reduced, and diffusion of the current to the both sides of a luminescence field can be controlled. And since high resistive layer 47b was formed in the both sides of mesa section 47a, it becomes possible to be able to reduce

further the current which flows on both sides of mesa section 47a, and to fall a threshold current more rather than the semiconductor laser shown with the 2nd operation gestalt.

[0072] Moreover, it also sets in this operation gestalt and is AlN. Since a layer 49 functions as a current [a transverse-mode control layer-cum-] constriction layer, contact area of the upper electrode 53 and the contact layer 51 can be enlarged, like the gestalt of the 2nd operation, contact resistance can be reduced and, thereby, element resistance can be lowered. In addition, the above-mentioned SiC They are silicon on sapphire and GaN instead of a substrate. A substrate etc. may be used. Moreover, for the presentation of a buffer and a clad, thickness and the presentation of a barrier layer, thickness, a well number of layers, etc., those layers are AlGaInN. If it is the material of a system, it will not be limited to the above-mentioned configuration.

[0073] Furthermore, the material of a mask 48 is not limited to SiO2, and may use other materials.

(Gestalt of the 4th operation) At the gestalt of the 3rd operation, it is 1st p-aluminum0.09Ga0.91N. Although the structure of having the high resistive layer formed in the both sides of the mesa section formed in the cladding layer and its mesa section is adopted, the mesa section may be omitted and an example of such structure is explained below.

[0074] First, drawing 16 (a) The MOCVD method is used so that it may be shown, and it is n mold carbonization silicon (SiC). On the field (0001) of a substrate 61 n mold (n-) aluminum0.09Ga0.91N with a thickness of 1.5 micrometers n-GaN with a clad [62] and a thickness of 100nm The SCH layer 63 and Undoping InGaN The multiplex quantum well (MQW) barrier layer 64 and p mold (p-) aluminum0.18Ga0.82N with a thickness of 20nm Are larger than 0 micrometer in the electron block layer 65, the p-GaN SCH layer 66 with a thickness of 100nm, and thickness. 1st p-aluminum0.09Ga0.91N 5 micrometers or less A cladding layer 67 is grown up in order, respectively.

[0075] The multiplex quantum well barrier layers 64 are four In0.03Ga0.97Ns. It is In0.15Ga0.85N between each of a barrier layer. It has the structure whose well layer was pinched. The barrier layer is 5nm and a well layer is 4nm in thickness. Next, 1st p-aluminum0.09Ga0.91N SiO2 film 68 is formed with a heat CVD method on a cladding layer 67 at the thickness of 300nm. Then, drawing 16 (b) Patterning of the SiO2 film is carried out by the photolithography method, patterning is carried out to width of face of 0.5-2.0 micrometers, for example, the stripe configuration of 1.5 micrometers, and this is used as a mask 68 so that it may be shown.

[0076] Next, drawing 16 (c) It is 1st p-aluminum0.09Ga0.91N by pouring a hydrogen ion into the both sides of a mask 68, or diffusing hydrogen so that it may be shown. The acceptor of the field which is not covered with a mask 68 among cladding layers 67 is inactivated, and the high resistive layer 69 is formed there. The high resistive layer 69 is 1st p-aluminum0.09Ga0.91N. It may be formed only into a cladding layer 67 and is drawing 16 (c). You may be formed in the depth which reaches the p-GaN SCH layer 66 so that it may be shown, and it is n-aluminum0.09Ga0.91N. It may be formed in the depth which reaches a cladding layer 62.

[0077] When forming the high resistive layer 69, it is 1st p-aluminum0.09Ga0.91N. From the upper surface of a cladding layer 67, as an element poured in or diffused, it may not be restricted to hydrogen and you may be nitrogen, an argon, etc.

Moreover, as the method of diffusion of the element, diffusion of the ion by annealing or ECR equipment in the inside of the ambient atmosphere containing the element is mentioned.

[0078] After that, it is drawing 17 (a). An ECR spatter is used so that it may be shown, and they are a mask 68 and 1st p-aluminum0.09Ga0.91N. The insulating AlN layer 70 is formed on a cladding layer 67 and the high resistive layer 69 at the thickness of 20nm. Then, it is AlN on a mask 68 by etching a mask 68 by fluoric acid. Lift off of the layer 70 is carried out. Thereby, it is drawing 17 (b). A opening is formed in the AlN layer 70 so that it may be shown, and it is 1st p-aluminum0.09Ga0.91N from the opening. A cladding layer 67 is exposed. AlN which remained by lift off A layer 70 functions as a current [a transverse-mode control layer-cum-] constriction layer.

[0079] Next, 2nd crystal growth is performed by the MOCVD method. Namely, drawing 17 (c) It is AlN so that it may be shown. A layer 70 and 1st p-aluminum0.09Ga0.91N To the upper surface of a cladding layer 67, it is 2nd p-aluminum0.09Ga0.91N. A cladding layer 71 and p-GaN The contact layer 72 is formed in the thickness of 0.7 micrometers and 0.05 micrometers. In this case, 1st p-aluminum0.09Ga0.91N Not only a cladding layer 67 top but AlN Also on a layer 70, crystal growth of a cladding layer 60 and the contact layer 61 is carried out. In addition, AlN Instead of a layer 70, they are insulating AlGaN and GaN. Or Si3N4 You may grow up by MOCVD and ECR and the cladding layer 71 formed on the film crystallizes one of layers.

[0080] After that, as shown in drawing 18 , on the contact layer 72, the insulator layer 73 which consists of SiO2 is formed, patterning of this is carried out by the photolithography method, and opening 73a is formed above the luminescence field. After that, the p lateral electrode 74 connected to the contact layer 72 is formed on the insulator layer 73 of the inside of opening 73a, and the circumference of it. Furthermore, SiC The n lateral electrode 75 is formed in the bottom of a substrate 61.

[0081] The fundamental structure of blue luminescence semiconductor laser is completed by the above. It is AlN by forming the high resistive layer 69 in fields other than the upper part of a luminescence field by the ion implantation or diffusion among the 1st cladding layer 67 in a production process which was described above. It is made to make the 1st cladding layer 67 at the layer 70 bottom into the shape of a mesa substantially.

[0082] Therefore, the 1st cladding layer 67 on the luminescence field of a barrier layer 64 is thickened, and it is AlN by ECR on it. By forming a layer 70, it is lost and it is the AlN to give a damage to the luminescence field of a barrier layer 64. Control of membrane formation of a layer 70 becomes easy, and the surface morphology stops deteriorating. Moreover, it can control that current spreads in the 1st cladding layer 67 formed in addition to the luminescence field, and it flows to it since the 1st cladding layer 67 of the both sides of a luminescence field is substantially made thin by formation of the high resistive layer 69, and reduction of a threshold is attained.

[0083] It sets in this operation gestalt and is AlN. Since a layer 70 and the high resistive layer 69 function as a current constriction layer, contact area of the upper electrode 63 and the contact layer 61 can be enlarged, contact resistance decreases by this, and element resistance falls. In addition, the above-mentioned SiC They are silicon on sapphire and GaN instead of a substrate. A substrate etc. may be used.

Moreover, for the presentation of a buffer and a clad, thickness and the presentation of a barrier layer, thickness, a well number of layers, etc., those layers are AlGaInN. If it is the material of a system, it will not be limited to the above-mentioned configuration.

[0084] Furthermore, the material of a mask 48 is not limited to SiO2, and may use other materials.

{The account of with }

(1) it inserts into a 1 conductivity-type cladding layer and an opposite conductivity-type cladding layer -- having -- III AlN which is larger than 0nm formed between one [said / at least] cladding layer and the barrier layer in one [at least] cladding layer of the barrier layer which consists of a group nitride, and a said 1 conductivity-type cladding layer or said opposite conductivity-type cladding layer, and has the thickness of 300nm or less from -- compound semiconductor laser characterized by having the becoming transverse-mode control layer.

(2) Semiconductor laser given in (1) to which said transverse-mode control layer is characterized by being inserted between said opposite conductivity-type cladding layers and barrier layers in said opposite conductivity-type cladding layer.

(3) Semiconductor laser given in (1) characterized by inserting said transverse-mode control layer between a cladding layer and a SCH layer.

(4) Semiconductor laser given in (1) characterized by inserting said transverse-mode control layer between a SCH layer and a barrier layer.

(5) It is AlN to the production process which forms a stripe-like mask layer on a substrate, and the substrate surface containing said mask layer. AlN formed in the side wall and the upper surface of said mask layer and mask layer using the production process which forms a layer, and the solution which can etch said mask layer The formation method of the semiconductor laser characterized by having the production process which carries out lift off of the layer.

(6) Said AlN A layer is the formation method of the semiconductor laser given in (5) characterized by being formed at the substrate temperature of 500 degrees C or less by the spatter.

(7) The thickness of said mask layer is said AlN. The formation method of the semiconductor laser given in (5) characterized by being 1.5 or more times of the thickness of a layer.

(8) The thickness of said mask layer is AlN. The formation method of the semiconductor laser given in (5) characterized by being the thickness exceeding 5 times of the thickness of a layer.

(9) (5) - (8) characterized by the cross section of said mask layer being a reverse mesa configuration -- the formation method of semiconductor laser given in either.

(10) (5) - (8) characterized by the cross section of said mask layer being a T character mold -- the formation method of semiconductor laser given in either.

(11) AlN which was formed in the current constriction field in the up cladding layer and lower cladding layer which bandgap energy consists of a large gallium nitride system compound semiconductor from the barrier layer which consists of a gallium nitride system compound semiconductor, and said barrier layer, and sandwich said barrier layer, and said up cladding layer, and has started on both sides of a current passage field Or AlGaN Or GaN from -- semiconductor luminescence equipment characterized by having the becoming insulating layer.

(12) The up cladding layer and lower cladding layer which bandgap energy consists of a large gallium nitride system compound semiconductor from the barrier layer

which consists of a gallium nitride system compound semiconductor, and said barrier layer, and sandwich said barrier layer, AlN which is formed in a current constriction field in said up cladding layer, and has a opening to a current passage field Or AlGaN Or the insulating layer for current constrictions which consists of GaN, Semiconductor luminescence equipment characterized by having the high resistance field where the impurity of said up cladding layer of said insulating-layer bottom was inactivated.
(13) Semiconductor luminescence equipment given in (12) characterized by introducing hydrogen, nitrogen, and an argon into said high resistance field.
(14) Said insulating layer is semiconductor luminescence equipment given in (12) characterized by having started on both sides of said current passage field.
(15) Said high resistance field is semiconductor luminescence equipment given in (12) characterized by having reached either said up cladding layer, said barrier layer or said lower cladding layer.
(16) The thickness of said insulating layer is semiconductor luminescence equipment given in (11) characterized by being 1nm - 30nm, or (12).
(17) Everything but the portion into which said insulating layer has started is semiconductor luminescence equipment given in (11) characterized by being parallel to said barrier layer, and (14) at either.
(18) It is semiconductor luminescence equipment given in (11), (14) or, and (17) characterized by the maximum angle to said barrier layer being larger than 30 degrees, and being smaller than 150 degrees among the portions which have started among said insulating layers.
(19) Semiconductor luminescence equipment given in (11) characterized by forming the SCH layer, respectively between said barrier layers and said up cladding layers and between said barrier layers and lower cladding layers, and (12).
(20) The production process which forms a 1 conductivity-type cladding layer on a substrate, and the production process which forms a barrier layer on said 1st conductivity-type cladding layer, The production process which forms the 1st opposite conductivity-type cladding layer on said barrier layer, and the production process which forms a stripe-like mask on said 1st opposite conductivity-type cladding layer, The production process which carries out dry etching of the field which is not covered with said mask, and forms the mesa section in said 1st opposite conductivity-type cladding layer at least, It is AlN on said mask and said 1st reverse conductivity-type cladding layer. Or AlGaN Or GaN The production process which forms the becoming insulating layer, The manufacture method of the semiconductor luminescence equipment characterized by having the production process which also removes said insulating layer on said mask by removing said mask, and the production process which forms the 2nd opposite conductivity-type cladding layer and contact layer on said insulating layer and said 1st opposite conductivity-type cladding layer.
(21) The production process which forms a 1 conductivity-type cladding layer on a substrate, and the production process which forms a barrier layer on said 1st conductivity-type cladding layer, The production process which forms the 1st opposite conductivity-type cladding layer on said barrier layer, and the production process which forms a stripe-like mask on said 1st opposite conductivity-type cladding layer, It is AlN on said mask and said 1st opposite conductivity-type cladding layer. Or AlGaN Or GaN The production process which forms the becoming insulating layer, The production process which introduces hydrogen,

nitrogen, or an argon into said 1st opposite conductivity-type cladding layer of the field which is not covered with said mask from the outside, and forms a high resistive layer, The manufacture method of the semiconductor luminescence equipment characterized by having the production process which also removes said insulating layer on said mask by removing said mask, and the production process which forms the 2nd opposite conductivity-type cladding layer and contact layer on said insulating layer and said 1st opposite conductivity-type cladding layer.

(22) The manufacture method of semiconductor luminescence equipment given in (21) characterized by having further the production process which carries out dry etching of the field which is not covered with said mask, and forms the mesa section in said 1st opposite conductivity-type cladding layer at least.

(23) Said hydrogen, said nitrogen, or said argon is the manufacture method of semiconductor luminescence equipment given in (21) characterized by being introduced into said 1st opposite conductivity-type cladding layer by the ion implantation.

(24) Said hydrogen, said nitrogen, or said argon is the manufacture method of semiconductor luminescence equipment given in (21) characterized by being introduced into said 1st opposite conductivity-type cladding layer by ECR equipment.

(25) The manufacture method of semiconductor luminescence equipment given in (22) characterized by introducing said hydrogen, said nitrogen, or said argon into said 1st opposite conductivity-type cladding layer by heating said 1st opposite conductivity-type cladding layer in the ambient atmosphere containing hydrogen, nitrogen, or an argon.

(26) The manufacture method of semiconductor luminescence equipment given in (20) or (22) characterized by the termination location of said etching being among said barrier layer.

(27) Said 1st opposite conductivity-type cladding layer is semiconductor luminescence equipment given in (20) or (21) characterized by being formed in the thickness of 5 micrometers or less more greatly than 0 micrometer.

(28) Said mesa section is the manufacture method of semiconductor luminescence equipment given in (20) or (21) characterized by being formed to said 1 conductivity-type cladding layer.

(29) Said 2nd opposite conductivity-type cladding layer is the manufacture method of semiconductor luminescence equipment given in (20) or (21) characterized by being formed in the thickness of 10nm - 3000nm.

(30) Said 1 conductivity-type cladding layer, said 1st opposite conductivity-type cladding layer, and said 2nd opposite conductivity-type cladding layer are the manufacture method of semiconductor luminescence equipment given in (20) or (21) characterized by consisting of materials with which each band gaps differ.

(31) It is the manufacture method of semiconductor luminescence equipment given in (20) or (21) characterized by forming at least two layers from the material with the same band gap among said 1 conductivity-type cladding layer, said 1st opposite conductivity-type cladding layer, and said 2nd opposite conductivity-type cladding layer.

(32) The width of face of said mesa section is the manufacture method of semiconductor luminescence equipment given in (20) or (22) characterized by being 0.5-20 micrometers.

(33) Said insulating layer is the manufacture method of semiconductor

luminescence equipment given in (20) or (21) characterized by being formed of an ECR spatter or MOCVD.
[0085]
[Effect of the Invention] According to [as stated above] this invention, it is AlN of 300nm or less of thickness between a cladding layer and the barrier layer in a cladding layer. Since the becoming transverse-mode control layer was prepared, transverse-mode control of group-III-V-semiconducter laser can become easy, the aspect ratio of the shape of beam can be improved, and, moreover, generating in high order former mode can be prevented. Moreover, AlN which constitutes a transverse-mode control layer The lift-off method will be adopted as a patterning method of a layer, the mask for lift off will cover a luminescence field by that, and it is AlN. The damage by growth and patterning of a layer can be reduced and a laser property can be improved.
[0086] Furthermore, since the structure where the side of a opening was started among the transverse-mode control layers formed in the above-mentioned cladding layer was adopted according to this invention, in case a transverse-mode control layer is formed, the luminescence field of a barrier layer can be protected by the thick cladding layer. And on both sides of a luminescence field, since the optical confinement layer is approaching the barrier layer, transverse-mode control can be made good, and the breadth of the current within a cladding layer can be controlled, and a threshold current can be reduced.
[0087] In this invention, since the high resistive layer was further formed in the bottom of a transverse-mode control layer, the breadth of the current within a cladding layer is controlled further, and can reduce a threshold current more. Furthermore, since the method of carrying out dry etching of the cladding layer was adopted in order to form the mesa section in the cladding layer on the barrier layer, there is much more current constriction effect.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 (a) and (b) It is drawing explaining the conventional technology.
[Drawing 2] Drawing 2 (a) and (b) It is the cross section showing the 1st and 2nd semiconductor laser concerning the 1st operation gestalt of this invention.
[Drawing 3] Drawing 3 (a) and (b) It is the perspective diagram showing the formation method of the transverse-mode control layer of the semiconductor laser concerning the 1st operation gestalt of this invention.
[Drawing 4] Drawing 4 (a) and (b) It is formation process drawing (the 1) of the 1st semiconductor laser concerning the 1st operation gestalt of this invention.
[Drawing 5] Drawing 5 (a) and (b) It is formation process drawing (the 2) of the 1st semiconductor laser concerning the 1st operation gestalt of this invention.
[Drawing 6] Drawing 6 (a) and (b) It is formation process drawing (the 3) of the 1st semiconductor laser concerning the 1st operation gestalt of this invention.
[Drawing 7] Drawing 7 (a) and (b) It is the perspective diagram (the 1) showing another formation production process of the transverse-mode control layer of the 1st semiconductor laser concerning the 1st operation gestalt of this invention.
[Drawing 8] Drawing 8 (a) and (b) It is the perspective diagram (the 2) showing another formation production process of the transverse-mode control layer of the 1st semiconductor laser concerning the 1st operation gestalt of this invention.
[Drawing 9] Drawing 9 (a) - (c) It is the cross section (the 1) showing the formation production process of the semiconductor laser concerning the 2nd operation gestalt of this invention.
[Drawing 10] Drawing 10 (a) - (c) It is the cross section (the 2) showing the formation production process of the semiconductor laser concerning the 2nd operation gestalt of this invention.
[Drawing 11] Drawing 11 is the cross section of the semiconductor laser concerning the 2nd operation gestalt of this invention.
[Drawing 12] Drawing 12 is property drawing of the semiconductor laser concerning the 2nd operation gestalt of this invention, and the semiconductor laser concerning the 1st operation gestalt.
[Drawing 13] Drawing 13 (a) - (c) It is the cross section (the 1) showing the formation production process of the semiconductor laser concerning the 3rd operation gestalt of this invention.
[Drawing 14] Drawing 14 (a) - (c) It is the cross section (the 2) showing the formation production process of the semiconductor laser concerning the 3rd operation gestalt of this invention.

[Drawing 15] Drawing 15 (a) and (b) It is the cross section (the 3) showing the formation production process of the semiconductor laser concerning the 3rd operation gestalt of this invention.
[Drawing 16] Drawing 16 (a) - (c) It is the cross section (the 1) showing the formation production process of the semiconductor laser concerning the 4th operation gestalt of this invention.
[Drawing 17] Drawing 17 (a) - (c) It is the cross section (the 2) showing the formation production process of the semiconductor laser concerning the 4th operation gestalt of this invention.
[Drawing 18] Drawing 18 is the cross section of the semiconductor laser concerning the 4th operation gestalt of this invention.
[Description of Notations]
1, 11, 31, 41, 61 A substrate, 2, 12, 32, 42, 62 -- n-AlGaN Cladding layer -- SiC 3, 13, 33, 43, 63 -- A n-GaN SCH layer, 4, 14, 34, 44, 64 -- InGaN Barrier layer, 5, 15, 35, 46, 66 -- A p-GaN SCH layer, 6, 16, 36, 47, 67 -- p-AlGaN Cladding layer, 47a -- The mesa section, 47b, 69 -- A high resistive layer, 7 and 17, and 38 a--AlN Transverse-mode control layer, 8, 18, 39, 50, 71 A cladding layer, 9, 19, 40, 51, 72 -- p-GaN Contact layer -- p-AlGaN 21, 25, 27, 37, 48, 68 -- A mask, 22, 38, 49, 70 -- AlN 45 A layer, 65 -- p-AlGaN Electron block layer.

[Translation done.]

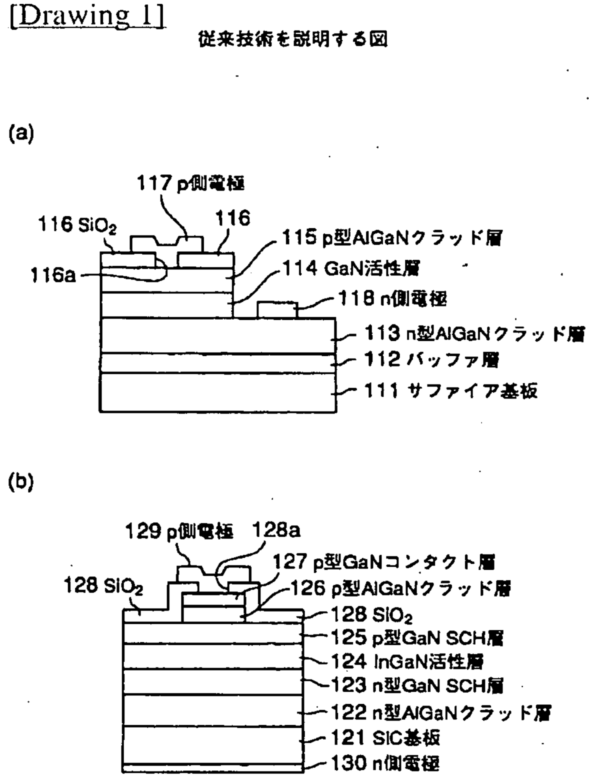
* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

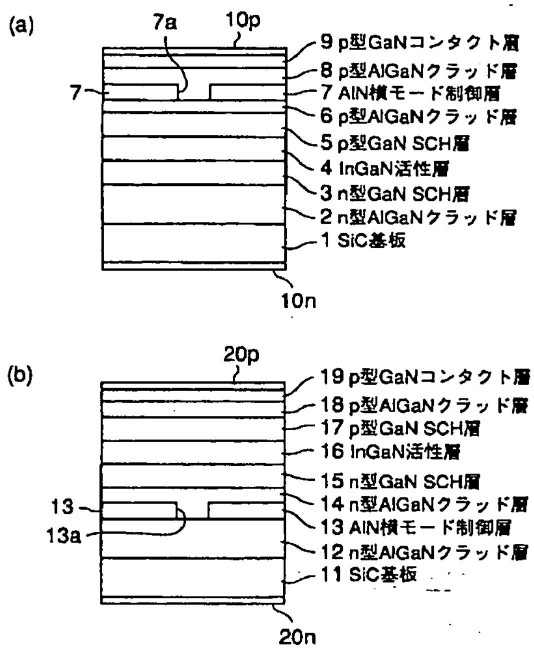
DRAWINGS

[Drawing 1]



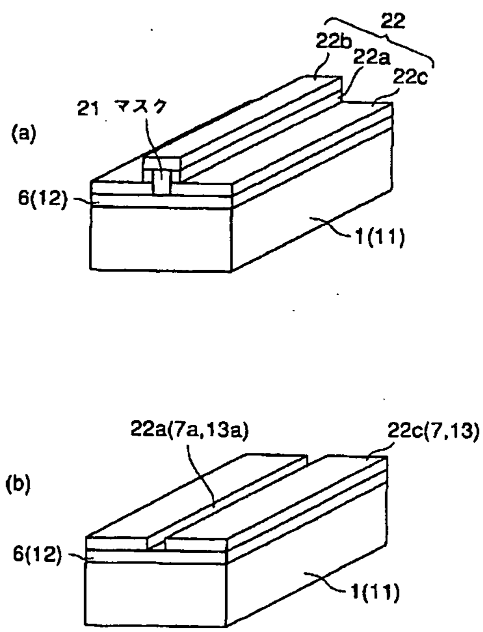
[Drawing 2]

本発明の第1実施形態に係る第1および第2の半導体レーザの断面図



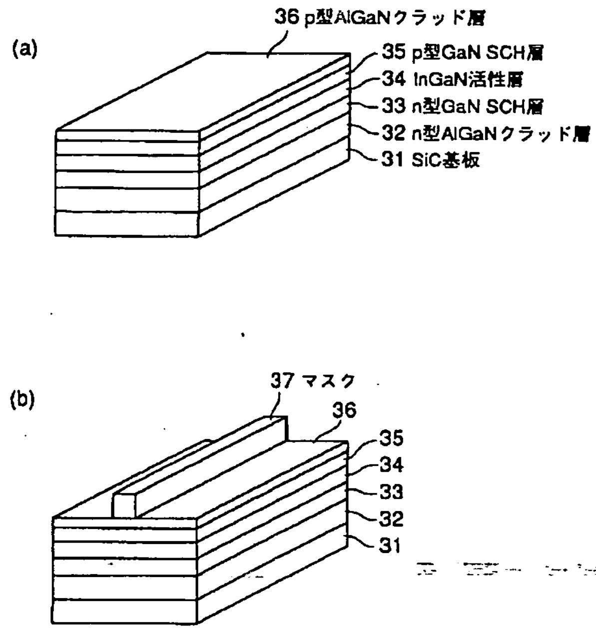
[Drawing 3]

本発明の第1実施形態に係る半導体レーザの横モード制御層の形成方法を示す斜視図



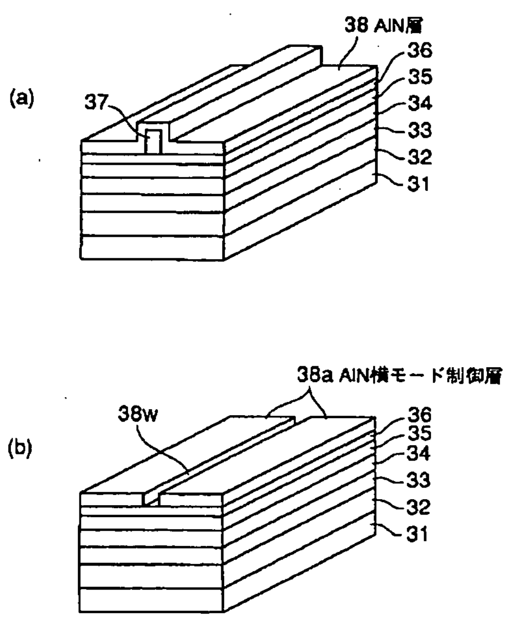
[Drawing 4]

本発明の第1実施形態に係る第1の半導体レーザの形成工程図（その1）



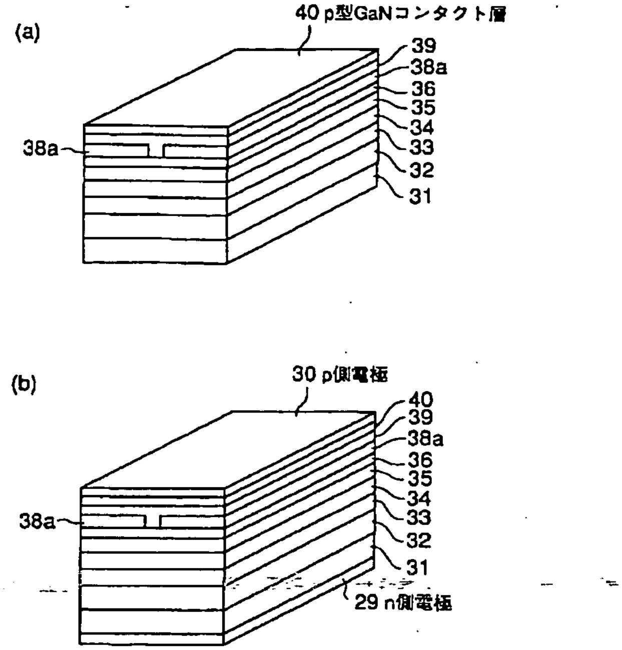
[Drawing 5]

本発明の第1実施形態に係る第1の半導体レーザの形成工程図（その2）



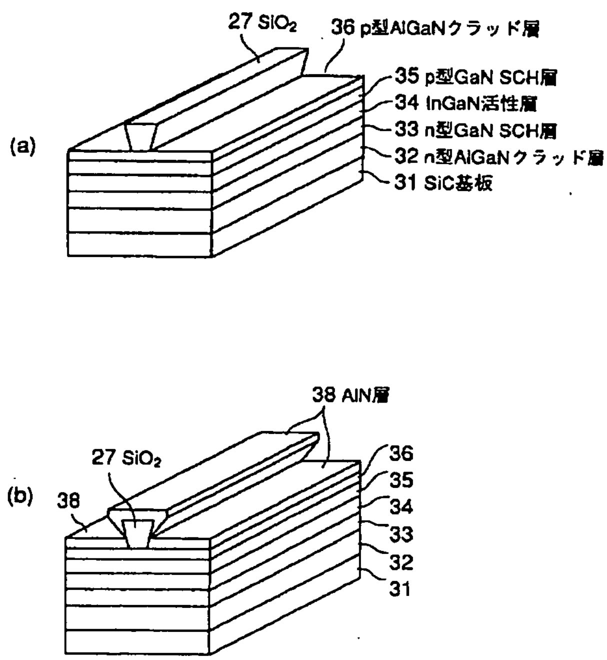
[Drawing 6]

本発明の第1実施形態に係る第1の半導体レーザの形成工程図（その3）

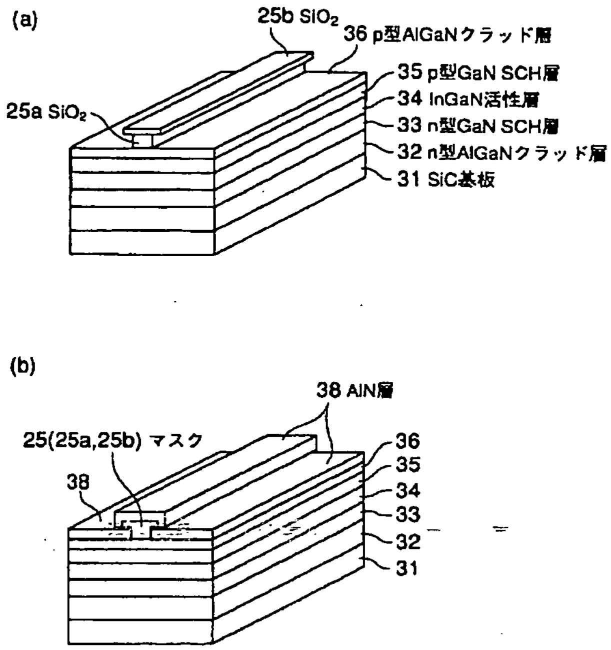


[Drawing 7]

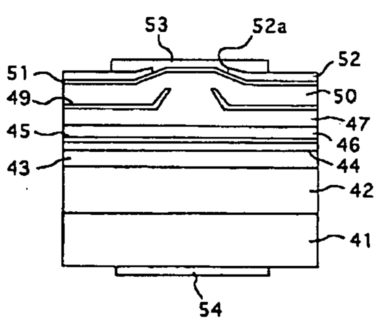
本発明の第1実施形態に係る第1の半導体レーザの横モード制御層の別な形成工程を示す斜視図（その1）



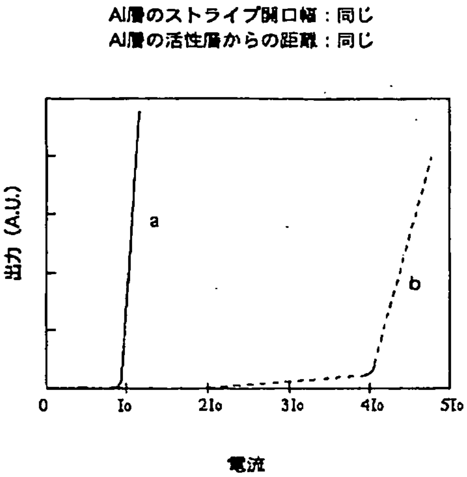
[Drawing 8]
本発明の第1実施形態に係る第1の半導体レーザの横モード制御層の
別な形成工程を示す斜視図（その2）



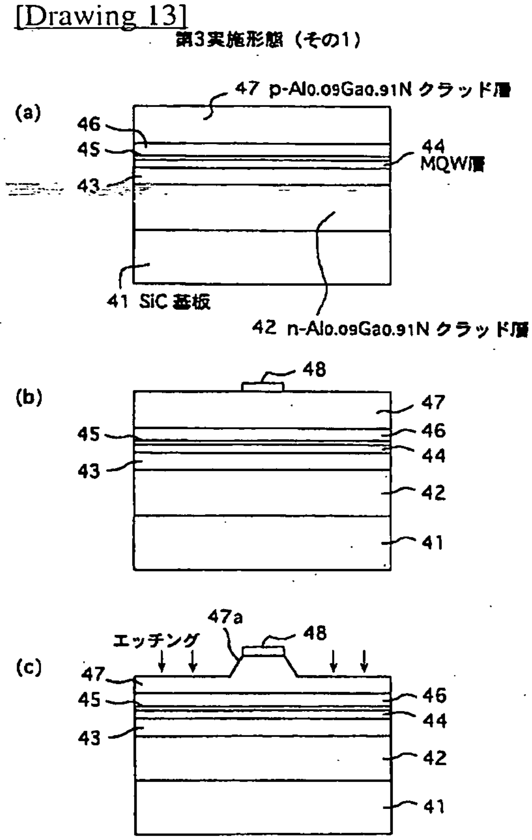
[Drawing 11]
第2実施形態（その3）



[Drawing 12]

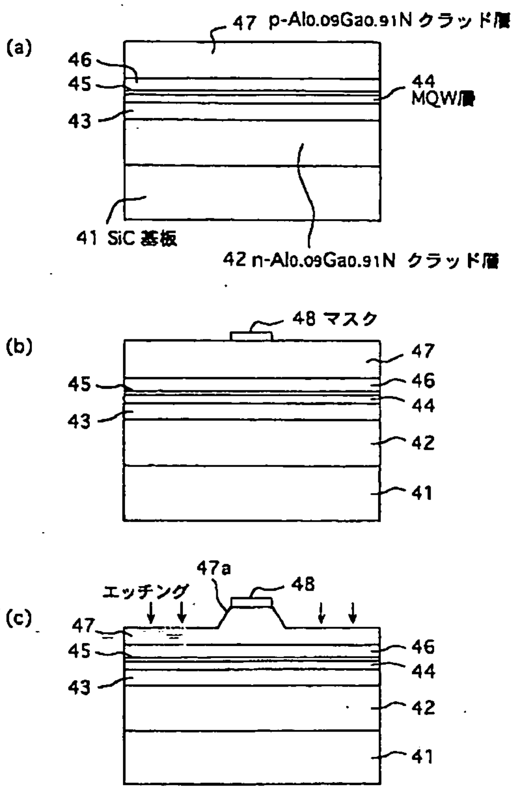


[Drawing 13]



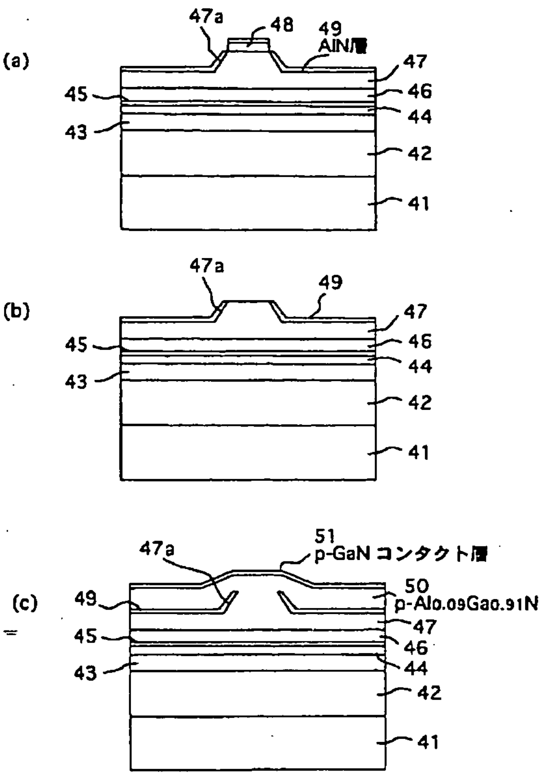
[Drawing 9]

第2実施形態（その1）



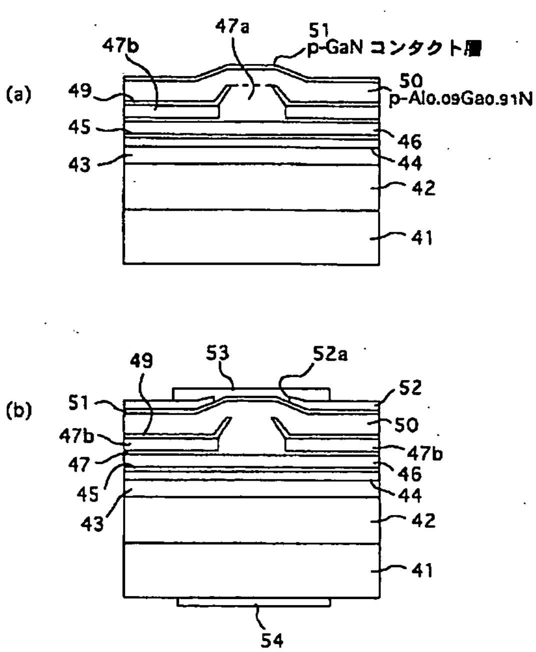
[Drawing 10]

第2実施形態（その2）



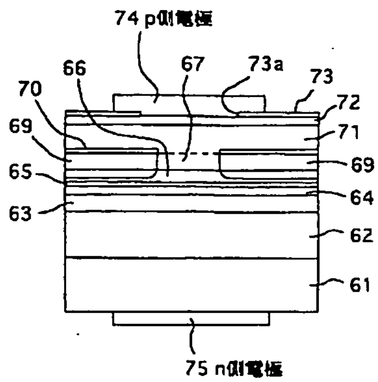
[Drawing 15]

第3実施形態（その3）



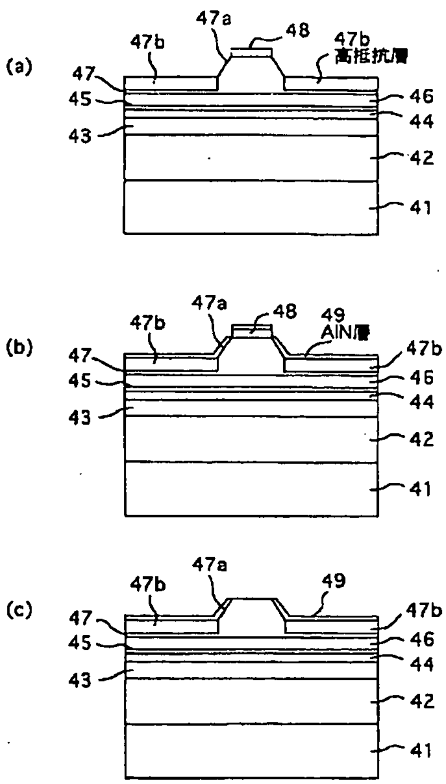
[Drawing 18]

第4実施形態（その3）

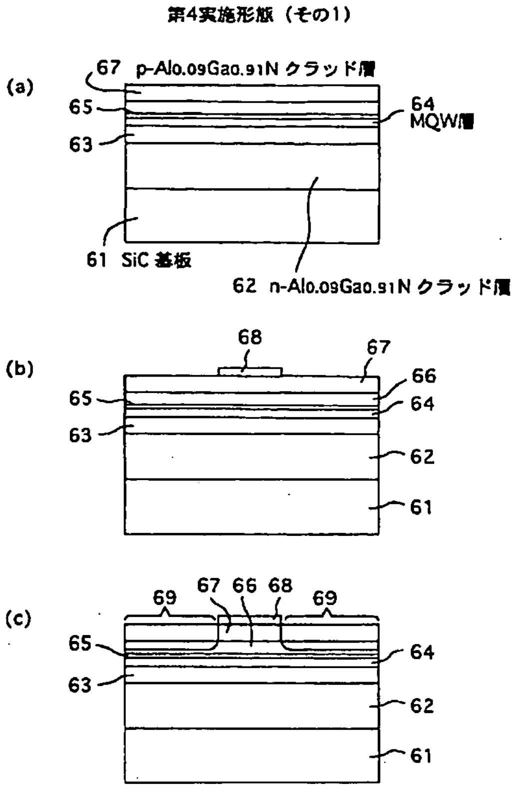


[Drawing 14]

第3実施形態（その2）

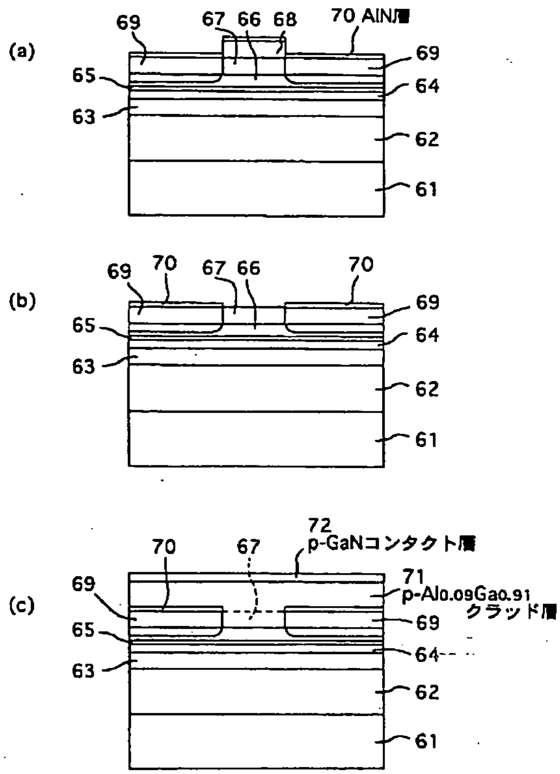


[Drawing 16]


第4実施形態（その1）
(a)
67 p-Al0.09Ga0.91N クラッド層
65
63
64
MQW層
61 SiC 基板
62 n-Al0.09Ga0.91N クラッド層
(b)
68
67
66
65
64
63
62
61
(c)
69
67
66
68
69
65
64
63
62
61

[Drawing 17]

第4実施形態（その2）



[Translation done.]